

Application Number: 10/016,896
Amendment dated July 23, 2004
Reply to Office action of May 4, 2004

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Remarks/Arguments

This response is being filed within the shortened three-month statutory period for responding to the final office action that was mailed on May 4, 2004. Therefore, no petition and fee for an extension of time are enclosed herewith.

Claims

Claims prior to this amendment are referred to as "currently pending" Claims. This response amends currently pending Claims 1 and 25. After amendment this application will have one independent Claim (currently amended Claim 1) and a total of 10 Claims (currently amended Claims 1 and 25 and currently pending Claims 2-7 and 23-24). Applicant previously paid for up to 20 total Claims and three independent Claims. Therefore, no fee for excess Claims is enclosed with this response.

The Applicant reserves the right to seek protection for any unclaimed subject matter either subsequently in the prosecution of the present case or in a divisional or continuation application.

Claim Rejection – 35 U.S.C. § 112, second paragraph

The Examiner rejects Claims 1 and 25 under 35 U.S.C. § 112, second paragraph as being indefinite for failing to particularly point out and distinctly claim the subject matter, which the applicant regards as the invention. Claims 1 and 25 were amended to overcome the rejection as suggested by the Examiner. It is therefore believed that the rejection is moot now.

Claim Rejection – 35 U.S.C. § 103(a)

The Examiner rejects Claims 1-7, 23-25 under 35 U.S.C. § 103(a) as being allegedly obvious over Kang (U.S. Patent Application No. 2002/0045353 A1) in view of Kim (U.S. Patent No. 6,316,349) and further in view of Thei (U.S. Patent No. 6,335,249), and further in view of Prall (U.S. Patent No. 6,337,244).

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Currently amended Claim 1 is an independent Claim. Claims 2-7 and 23-25 are directly or indirectly dependent from Claim 1.

Currently amended independent Claim 1 has the following limitations.

A method of forming a self-aligned contact hole suitable for a semiconductor substrate having a pair of gate electrodes, comprising:

forming a nitride etching stop layer over the gate electrode and the semiconductor substrate;

forming an oxide insulating layer on the nitride etching stop layer; and

plasma-etching the oxide insulating layer by an etching gas consisting of C_5F_8 and CHF_3 so as to form a self-aligned contact hole between the pair of gate electrodes,

wherein the C_5F_8 and CHF_3 mixture ratio of the etching gas is between 0.4 and 0.75,

thereby equalizing the etching rate to the etching stop layer at the top corner and the bottom of the contact hole.

Rejection of independent Claim 1 under 35 U.S.C. § 103(a)

The Examiner rejects independent Claim 1 under 35 U.S.C. § 103(a) over Kang in view of Prall. The Examiner asserts that Kang teaches a method of forming a self-aligned contact hole by etching the silicon oxide layer using $C_5F_8/CHF_3/Ar$, but fail to teach the specific C_5F_8/CHF_3 mixture ratio of the etching gas than is between 0.4 and 0.75. The Examiner further asserts that nevertheless, using C_5F_8/CHF_3 mixture ratio of etching gas that is between 0.4 and 0.75 to etch oxide layer is evidenced by Prall. In order to justify the assertion the Examiner points out that Prall teaches forming a self-aligned contact hole using a mixture of $C_5F_8/ClIF_3$ of ratio of between about 0.2-5 (Prall, claim 6, 39 and col. 6, lines 27-35 and col. 8, lines 1-14). The Examiner makes the assertions mentioned in the preceding sentences in the second paragraph on page 6 of the Office action.

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The Applicants respectfully traverse the rejection of Claim 1 under 35 U.S.C. § 103(a) over Kang in view of Prall for the following reasons.

The mixture of C_5F_8 and CHF_3 with ratio between 0.4 and 0.75 according to Claim 1 is not disclosed or suggested in the cited documents as acknowledged by the Examiner. The prior art references or even references when combined do not teach or suggest all the Claim limitations of Claim 1 for this reason.

The Examiner asserts further that it would have been obvious to a person skilled in the art to use C_5F_8 and CHF_3 gas mixture with a ratio between 0.4 and 0.75 to etch a self-aligned contact hole in the process of Kang because the higher the etching selectivity of silicon oxide to silicon nitride layer would prevent over etching on the gate electrode in paragraph 2 on page 7 of the office action. The Applicants respectfully traverse the Examiner's assertion.

The Applicants respectfully submit that the etching rate to the etching stop layer at the top corner and the bottom of the contact hole are equalized when the mixture of C_5F_8 and CHF_3 etching gas is between 0.4 and 0.75. The Applicants respectfully submit that the requirement for equalizing both the etching rate at the top corner and the bottom of the contact hole is that the etching selectivity of the oxide and the nitride on the gate electrode and the etching selectivity of the oxide and the nitride on the substrate need to be considered. This is critical in order that neither the top corner nor the bottom of the contact hole is over-etched. Accordingly, the narrow range between 0.4 and 0.75 provides unexpected advantages in view of the combination of the prior art teachings.

The Applicants respectfully submits that neither Kang nor Prang suggest to modify the combined teaching in order to select the ratio of the etching gas mixture of C_5F_8 and CHF_3 between 0.4 and 0.75 and thereby equalizing the etching rate to the etching stop layer at the top corner and the bottom of the contact hole.

The Applicants further submit that Prall teaches forming a self-aligned contact hole using mixture of C_5F_8 and CHF_3 gas at ratio between about 0.2-5. However, Applicants respectfully submit that neither Kang nor Prall provide a

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nitride etching stop layer at the bottom of the contact hole. See for Example Fig. 2A of Kang and Fig. 2 of Prall. However Claim 1 of the application recites: "forming a nitride etching stop layer over the gate electrode and the semiconductor substrate." Therefore, the combined prior art does not teach or suggest this element as well.

The Applicants respectfully submit that the contact hole etching concerns the etching selectivity at the top corner of the contact hole and the etching selectivity at the bottom of the contact hole. Consequently, one of ordinary skill in the art could not have been motivated to optimize the etching parameters of Kang and Prall to equalized the etching rates to the nitride etching stop layer at the top corner and the bottom of the contact hole. Because there would be no need to do that since both Kang and Prall teach to have no nitride etching stop layer at the bottom of the contact hole. There is simply no suggestion or motivation in the references themselves to combine the references or to modify the reference teachings.

Kang and Prall do not teach or suggest forming a nitride etching stop layer over the gate electrode and the semiconductor substrate therefore to have a nitride etching stop layer at the bottom of the contact hole and Prall teaches using mixture of C_5F_8 and CHF_3 gas at ratio between about 0.2-5. There would be no reasonable expectation of success to combine the teachings of Kang and Prall. The combined teaching of Kang and Prall would be only successful to improve the method of forming a self-aligned contact hole suitable for a semiconductor substrate having a pair of gate electrodes, wherein no nitride etching stop layer would be at the bottom of the contact hole and a mixture of C_5F_8 and CHF_3 gas at ratio between about 0.2-5 would be used. The combined teaching of Kang and Prall teaches away from Claims 1.

Furthermore and for the foregoing reasons, the limitation of "wherein the C_5F_8 and CHF_3 mixture ratio of the etching gas is between 0.4 and 0.75, thereby equalizing the etching rate to the etching stop layer at the top corner and the bottom of the contact hole" may not be recognized as a result-effective viable, i.e., a variable which achieves a recognized result, before the determination of the optimum or

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workable ranges of said variable might be characterized as routine experimentation. First of all the range between 0.4 and 0.75 compared to a range between 0.2 to 5 as disclosed by Prall is a small range. It would require an unreasonable effort to find this range to be advantageous out of the large range. Further, there is no suggestion in the combined teaching to modify the large range at all. Finally, there is no suggestion in the prior art to equalizing the etching rate to the etching stop layer at the top corner and the bottom of the contact hole. There would be therefore no motivation what so ever for the person skilled in the art to modify the range between 0.2 and 5 to find the range between 0.4 and 0.75.

For the foregoing reasons the Applicants submit that the Examiner failed to establish a prima facie case of obviousness of Claim 1. The teaching or suggestion to make the claimed combination and the reasonable expectation of success can only be found in the Applicant's disclosure and not in the prior art. It is believed that the independent Claim 1 is allowable and since the independent Claim 1 is allowable the dependent Claims 2-7 and 23-25 are allowable as well.

Applicant respectfully requests that the rejection of currently amended Claims 1, 25 and currently pending Claims 2-7 and 23-24 on the above prior art grounds be withdrawn. If the Examiner rejects those Claims on the above prior art grounds, the Applicant requests that the Examiner show how the references teach or suggest every element of the rejected Claims. The Applicant further requests that the Examiner show where the motivation for making the suggested combination can be found in the cited references. It is believed those currently amended Claims 1, 25 and currently amended Claims 2-7 and 23-24 are allowable.

Accordingly, reconsideration and examination of the present application is respectfully requested. The application is now in condition for allowance. Allowance of the application at an early date is respectfully requested. Applicants reserve the right to seek protection for any unclaimed subject matter, either subsequently in the prosecution of the present case or in a divisional or continuation application.

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This response amends currently pending Claims 1 and 25. The amendments described above were done to clarify the subject matter, which the Applicant considers to be the invention. The amendments described above shall not be considered necessary to overcome rejections under 35 U.S.C. 112, shall not be considered necessary to overcome the prior art, and shall not be considered necessary to overcome any other rejections or objections.

The Commissioner is authorized to charge any additional fees, which may be required or credit overpayment to deposit account no. 12-0415. In particular, if this response is not timely filed, then the Commissioner is authorized to treat this response as including a petition to extend the time period pursuant to 37 CFR 1.136 (a) requesting an extension of time of the number of months necessary to make this response timely filed. The petition fee due in connection therewith may be charged to deposit account no. 12-0415.

I hereby certify that this correspondence is being facsimile transmitted to Fax No. 703-872-9306 and addressed to: Commissioner for Patents, PO Box 1450, Alexandria, VA 22313-1450 on

Respectfully submitted,

July 23, 2004

(Date of Deposit)

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(Name of Person Signing)

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